Scanning laser Doppler vibrometry

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Marie Brøns, Jon Juel Thomsen

Section of Solid Mechanics, Department of Mechanical Engineering, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark

e-mail: brons.marie@gmail.com, jjt@mek.dtu.dk

Marie Brøns, MSc student. Current theoretical and experimental MSc thesis work on modified Timoshenko beam theories. User of the scanning laser facility at MEK, DTU.

Jon Juel Thomsen, assoc. prof., dr.techn. Longtime teaching & research in theoretical and experimental vibration analysis. Responsible for the scanning laser facility at MEK, DTU.

Abstract

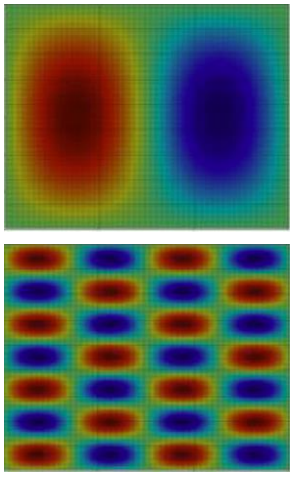
With a *Scanning Laser Doppler Vibrometer* (SLDV) a vibrating surface is automatically scanned over predefined grid points, and data processed for displaying vibration properties like mode shapes, natural frequencies, damping ratios, and operational deflection shapes. Our SLDV – a PSV-500H from Polytec Inc. – was acquired and put to operation in October 2014, paid by a sub-donation of DKK 1,5 mill. of the total VILLUM CASMaT grant. Opening possibilities of measuring complicated vibration shapes of almost any object – contactless, mostly automatically, and with only a single transducer – this costly equipment had been top priority on our wish list for many years.

The equipment is installed in suitably protected environments in a lockable small room in the larger lab.-building 414/041 at DTU Lyngby Campus, just next to our Brüel & Kjær PULSE open space lab. for more traditional vibration analysis (using accelerometers or other single-point transducers). In the talk we provide a brief account of what can be done with the equipment, and some examples of recent and planned usage. Some main features of the equipment are listed below.

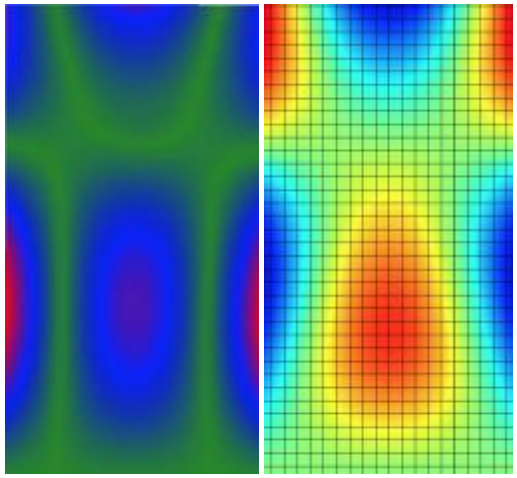
- Measures *velocity*, *1D*/out-of-plane (optionally 3D), non-contact, full-field, stationary and transient
- Range: Velocity 0.001-10 m/s; Deformation > 0.1 mm; Frequency 0-100 kHz; Distance 0.12-100 m
- Measurement objects: > 1 mm (smaller with an optional microscope front); Generally 3D / curved, with a diffusively reflecting surface (i.e. *not* glossy black or like a window or mirror)
- 3D object geometry definition by (ordinary) distance laser sensor
- Easy scan grid definition / re-definition, typically takes a few seconds
- Spatial scan rate up to 50 points/s; full scans take from seconds to hours, typically unsupervised
- Built-in signal generator for driving object exciters (shaker, piezo discs, loudspeaker,..) using, e.g., swept sine, burst/stationary random, or impulse signals
- Easy export to common commercial modal analysis program (we use ME'Scope)
- Well suited for standard shaker testing; handles input e.g. from force transducers or other reference signals to calculate frequency response and coherence functions
- Available for use by CASMaT associates that already holds some expertise in standard experimental vibration testing. A lab. technician will get a new user started by demoing a simple standard measurement. Beyond that the user will generally need to bring in or acquire his/her own expertise.

The PSV-500H scanning laser vibrometer [Polytex Inc.], and an example test object [Joensen 2015]

Guitar body & neck mode shapes @193/1038 Hz [Joensen 2015]



Thin plate mode shapes @608/10114 Hz. [Joensen 2015]



Clamped plate mode shapes, measured (left) and theoretically predicted (right) [Støme 2016]